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# Taxonomic Significance of Some Floral Characters in *Helonias* and *Ypsilandra* (Liliaceae)

Noriyuki TANAKA

Department of Education, School of Liberal Arts, Teikyo University,
359 Ôtsuka, Hachiôji-shi, Tokyo, 192-03 JAPAN

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Four floral characters of *Helonias bullata* and four species of *Ypsilandra* were compared. As a result, the following facts have been disclosed. (1) *Helonias* has often been described to possess three separate styles, but results showed that they are often connated to form a very short column at the base. As *Ypsilandra* also has a connate and columnar part in its stylar structure, this character of forming a column is common to both genera. (2) Although the anthers of *Helonias* have been reported to be bilocular, evidence revealed that they are in fact unilocular. As *Ypsilandra* has also unilocular anthers, this character is shared by the two genera. (3) Both genera were shown to possess the same character on the basal part of the filament; i.e., the basal part of the inner filament is adnate to the basal part of the ovary, while the same part of the outer filament is free from the ovary, in anthesis. (4) Contrary to previous reports, it turned out that *Helonias* has nectaries, and this character is also shared by *Ypsilandra*. All these facts not only suggest that the two genera are very closely related to each other, but also throw doubt on the current taxonomic practice of separating them in generic rank. It seems more appropriate to treat them under the same genus.

*Helonias* is a monotypic genus distributed in eastern North America (Gray 1859, Baker 1879, Bentham 1883, Engler 1888, Robinson and Fernald 1908, Britton and Brown 1913, Krause 1930, Fernald 1950, Gleason 1952, Radford et al. 1964), while *Ypsilandra* is a small genus comprising four species (Chen 1980, Yang 1991) distributed in eastern Asia ranging from the Himalayan range eastward to southeastern China (Franchet 1887, Krause 1930, Hutchinson 1934, Hara et al. 1978, Chen 1980, Yang 1991, Noltie 1994). Although the two genera are distributed disjunctively in the two separate continents, they are generally regarded as close allies (Krause 1930, Hutchinson 1934, Kawano in Kawano and Masuda 1980, Kawano 1996).

In order to clarify the phylogenetic relationship and to have the proper taxonomic evaluation, it is necessary to conduct detailed comparative surveys on the various characters of the two genera. In this study, I have compared some floral characters of the two genera, and as a result, some noteworthy facts have been disclosed. In this paper, I intend to report the results of observations on four floral characters and to discuss their taxonomic significance.

## Materials and Methods

The species investigated are *Helonias bullata* L. and four species of *Ypsilandra*; *Y. yunnanensis* W.W. Smith & J.F. Jeffrey, *Y. alpina* Wang & Tang, *Y. cavaleriei* Lévl. &

Vnt., and *Y. thibetica* Franchet.

Living plants of *H. bulalta* were provided from the Royal Botanic Garden Edinburgh, Scotland, and those of *Y. thibetica* were obtained from some cultivated sources in Japan. The accession number given for the living plants of *H. bullata* by the Edinburgh Bot. Gard. is 19694729. The wild origins of these living plants of both *Helonias* and *Ypsilandra* are unknown. These living plants were cultivated at the experimental nurseries of Teikyo University in Hachiôji, Tokyo. Floral characters were surveyed in these living materials as well as in several herbarium specimens which represent one species of *Helonias* and four species of *Ypsilandra* aforementioned. The specimens examined in this study are listed in the latter part of this paper. The voucher specimens of living plants of *H. bullata* and *Y. thibetica* are kept in our laboratory at Teikyo University. For closer examination of the flowers a stereoscopic microscope was used.

## Results and Discussion

### (1) Styles

*Helonias* has often been described to possess three separate styles (Baker 1879, Engler 1888, Britton and Brown 1913, Krause 1930, Gleason 1952, Utech 1978). In my materials also, it was observed that there are certainly many flowers of which styles look to be separated from the base, but at the same time it was also observed that there are not a few flowers of which styles are connated to form a very short column at the base (Figs. 1A and 1B). A similar observation has also been made by Bentham (1883), who described the styles of *Helonias* as follows; "styli 3, ..distincti v. breviter connati,..". The presence of column forming in *Helonias* seems important, since this character is also possessed by *Ypsilandra*. In *Ypsilandra*, the three styles are consistently connated either partially or entirely along their lengths to form a more or less columnar structure (Fig. 3A). This was confirmed in all of the four species of my materials, and this observation coincides with previous reports (Chen 1980, etc.). More details of the stylar characters of the two genera will be reported elsewhere.

### (2) Anthers

The anthers of *Helonias* have been reported

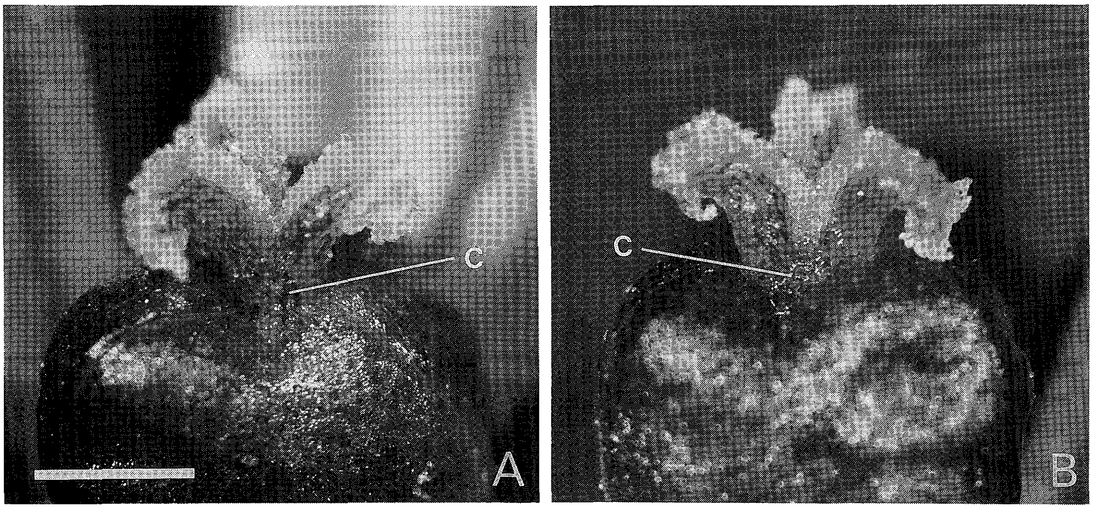

Fig. 1. Upper part of a pistil of two different flowers (A and B) of *Helonias bullata*, showing the basal connation (indicated by 'c') among the three styles. Scale bar, 1 mm.

to be bilocular (Gray 1859, Baker 1879, Robinson and Fernald 1908, Fernald 1950, Utech 1978), and the presence of the thecal confluence in this genus is negated by Utech (1978). Contrarily, the anthers of *Ypsilandra* have been known to be unilocular (Franchet

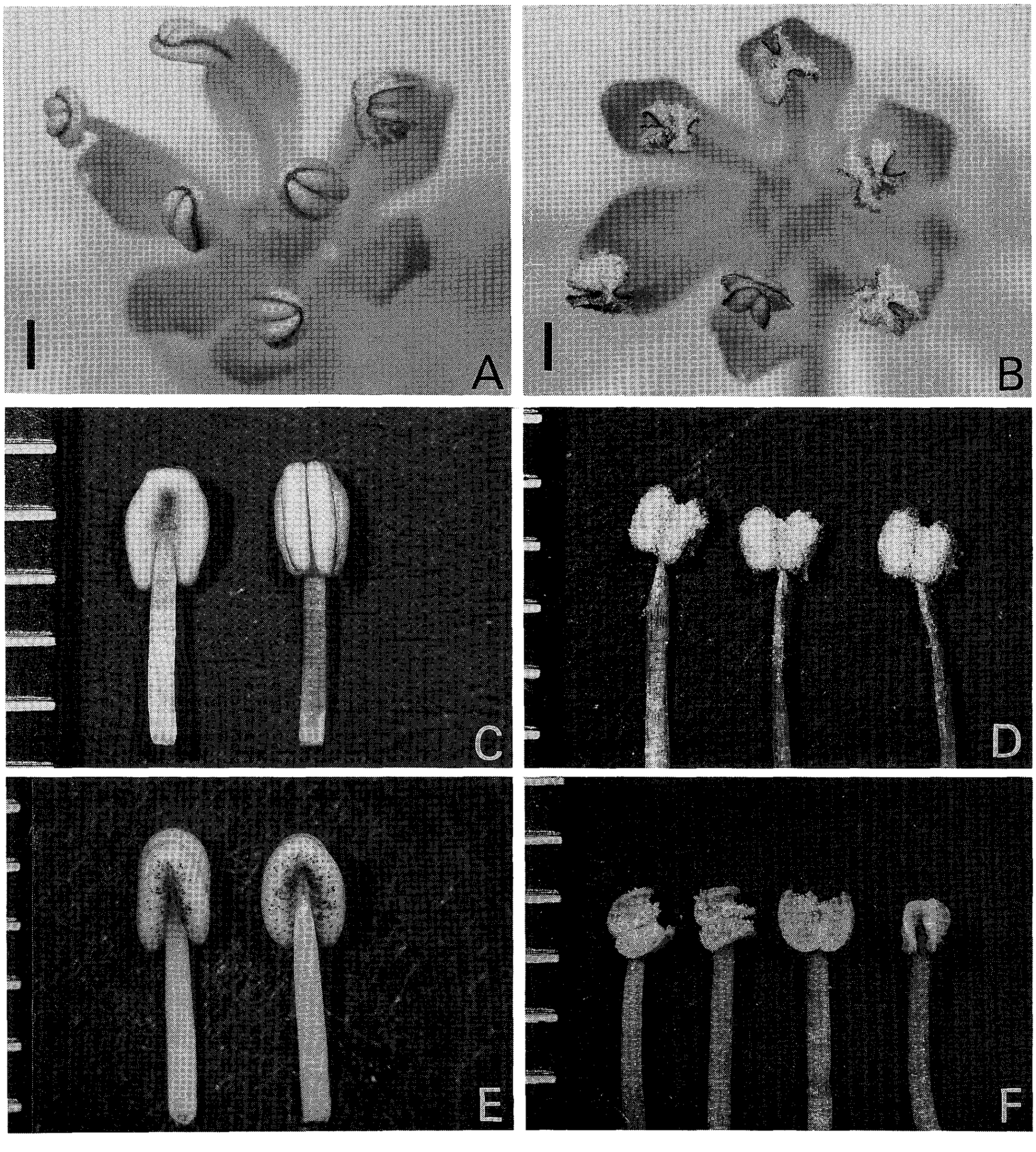

Fig. 2. Anthers of *Helonias* and *Ypsilandra*. A–D: *H. bullata*. A and B. Front view of a flower with undehiscent and dehiscent anthers. C. Two stamens. Left; pistil side view. Right; tepal side view. Note that there is no terminal boundary between the thecae on the pistil side of the anther. D. Dehisced anthers. E, F: *Y. thibetica*. E. Two stamens. Left; pistil side view. Right; tepal side view. F. Dehisced anthers. Note the presence of a thecal confluence in both genera. Scale bars in A and B, 1 mm. Scales in C–F in mm.

1887, Krause 1930, Chen 1980, Yang 1991). Accordingly, as far as these reports are concerned, it is said that the two genera differ in the anther structure. However, in my observations, it turned out that the anthers of *Helonias* are unilocular, being confluent terminally between the two neighbouring thecae (Figs. 2A–2D). Furthermore, it was also confirmed in living material from Edinburgh Botanic Garden that pollen grains are actually formed even at the confluent part between the thecae (Figs. 2A, 2B). The anthers of *Helonias* are extrorse. The dorsal side of the anthers (i.e., the pistil side of the anthers, in this case) has neither any bordering groove nor septum between the upper part of the thecae, looking like a horseshoe, while the ventral side of the anthers (i.e., the tepal side of the anthers) has a distinct, narrow bordering-groove between the thecae, looking like an ordinary bilocular anther (Figs. 2A–2C). However, as stated above, there certainly exists a confluent part between the thecae, and the groove between the thecae on the ventral side is only external. Meanwhile, it was confirmed in all of the four species of *Ypsilandra* of my materials that the anthers are perfectly unilocular, without any bordering-groove between the thecae on both sides, look-

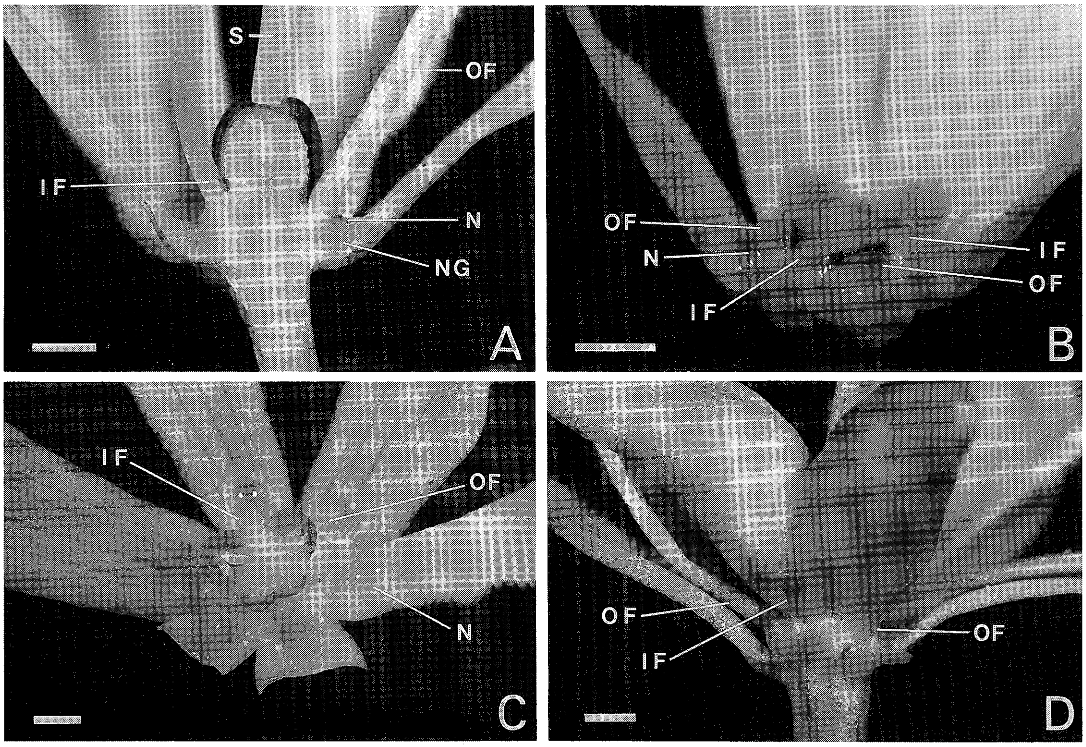

Fig. 3. Basal parts of the filaments of *Ypsilandra*. A–D: *Y. thibetica*. A. Longitudinal section of a flower. IF; inner filament. OF; outer filament. S; style. N; nectar. NG; nectary gland. B and C. Basal parts of various floral parts (an ovary, all the filaments and two tepals are cut off near their bases). Note that the inner filaments are adnate to the base of an ovary, while the outer filaments are not. D. Lower part of a capsule. Two filaments and two tepals are cut off near their bases. The basal part of the inner filament is adnate to the basal part of the capsule, while outer filaments come out from the capsule's stipe. Scale bar, 1 mm.

ing like horse-shoes (Fig. 2E). These observations in *Ypsilandra* are more or less consistent with former records (Chen 1980, etc.). Dehisced anthers of both genera are morphologically very similar to each other (Figs. 2D & 2F).

(3) **Filaments**

It is known that in *Helonias* the basal part of the inner filament is adnate to the basal part of the ovary, while there is no such adnation between the outer filament and the ovary (Utech 1978). The presence of this character was also confirmed in my materials of this genus. Meanwhile, I have also attempted to examine whether this character is present or not in *Ypsilandra*. As a result, it was proved that this character is also present consistently in all of the four species of *Ypsilandra* (Figs. 3A–3C: *Y. thibetica*). However, in *Y. thibetica*, it was observed that the basal part of the ovary tends to elongate slightly to form a very short stipe after anthesis, and some outer filaments come out from this stipe (Fig. 3D).

(4) **Nectaries**

It is particularly interesting to know whether the species in question has a nectary or not, when we are concerned with floral evolution. Regarding this point, some of the literature (Robinson and Fernald 1908, Fernald 1950, Utech 1978) describes *Helonias* as having no nectary glands. However, in my living material from Edinburgh, it was observed that every flower actually secretes nectar during anthesis (Fig. 4). The nectary is located at the base of the ventral side of each tepal. The presence of the nectar-secretion was also confirmed in some living plants of *Ypsilandra thibetica* (Figs. 3A–3C). The nectary of this species is also located at the same part of each tepal as is that of *Helonias*. Meanwhile, living materials of three other species of *Ypsilandra* were not available in this study, and therefore the nectar-secretion could not directly be observed in these species. But, judging from the morphology of the basal part of the tepal, it is highly likely that these three species also secrete nectar. In these species, the basal part on the

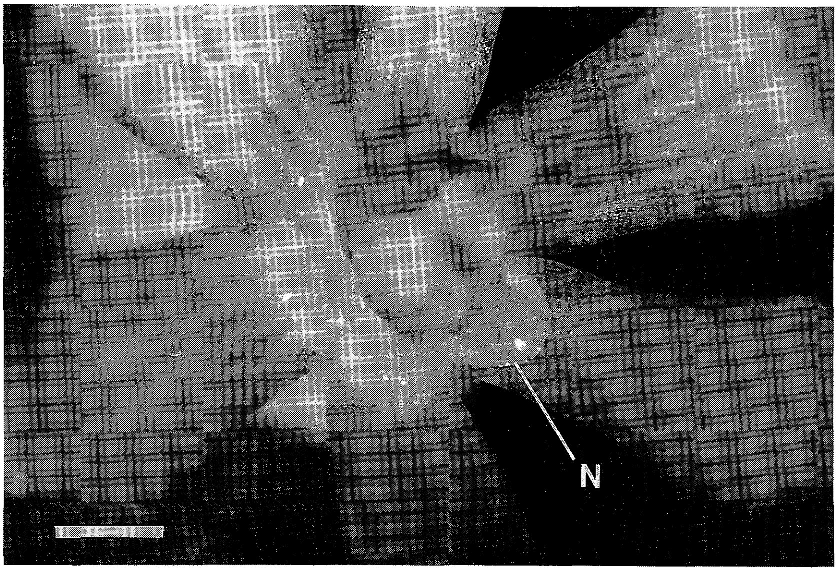

Fig. 4. Front view of a flower of *Helonias bullata*, showing the secretion of nectar (N). The stamens are removed near their bases. Scale bar, 1 mm.

dorsal side of each tepal is slightly convexed, while the same part on the ventral side is nearly flat or very slightly concave. These morphological features coincide with those of the species (*H. bullata* and *Y. thibetica*, Figs. 3A–3D) confirmed to secrete nectar.

*Helonias* and *Ypsilandra* have been distinguished mainly by the characters of both the style and the anther. However, as stated above, it turned out that the two genera possess the same characteristic in regard to these two structures. Furthermore, they also share the same characteristic regarding both the filament and the nectary.

All these facts not only suggest that the two genera are very closely related to each other, but also throw doubt on the current taxonomic practice of separating them in generic rank. It seems more appropriate to regard them as congeneric.

In this paper, only four floral characters were taken up. Needless to say, it is necessary to compare many other characters in order to increase clarity regarding the relationship of the two genera. Furthermore, as the two genera are also very closely related to *Heloniopsis* of eastern Asia, we need to study them along with this genus.

## Specimens examined

**Helonias bullata:** Budd's Lake, Morris Co., New Jersey. May 7, 1905 (fl.), June 11, 1905 (fr.). Kenneth K. Mackenzie, n. 1209 (E); Hort. Edin. May 14, 95. fl.-sp. (E); Cultivated plant at Royal Botanic Gardens Edinburgh, acces. no. 19694729. Transplanted to Teikyo Univ. N. Tanaka, s.n. (Biol. Lab., Teikyo Univ.).

**Ypsilandra yunnanesis:** Mekong-Salween divide, Yunnan. Lat. 28°10'N. Alt. 12000 ft. Sept. 1917. G. Forrest, n. 14961. fr.-sp. (E); Shweli-Salween divide, Yunnan. Lat. 25°20'N. Alt. 9000 ft. Aug. 1913. G. Forrest, n. 12055. fl.-sp. Type. (E); Mountains above Tseku and Tsehchung, Mekong-Salween watershed. N.W. Yunnan. 1923. J.F. Rock, n. 10091. fl.-sp. (E).

**Y. alpina:** Frontier of Tibet and Burma, Sarig hku wang. 28°8'N, 97°24'E. Alt. 14000 ft. 9.7.1926. F. Kingdon-Ward, n. 7084. fl.-sp. Type. (E).

**Y. cavaleriei:** Kouy-Tcheou, Chine. Alt. 1450 m. Avril 1910. J. Esquirol, n. 2013. fl.-sp. (E); S.E. Kouy-Tcheou, environs de Touchan, dans la montagne. 3 Juin 1899. J. Cavalerie, n. 2638 (in Herb. Bodinier). fr.-sp. Holotype. (E).

**Y. thibetica:** Kouy-Tcheou, Pin-fa, montagnes, liux humides. 10 Mars 1902. J. Cavalerie, n. 1291. fl.-sp. (E); Mt. Omei, Sichuan prov., China. Cult. at Nikko Bot. Gard. Univ. Tokyo. May 12, 1996. (fl.)–fr.-sp. (MAK); Wild origin unknown (plants were obtained from cultivated sources), cultivated at Teikyo University. N. Tanaka, s.n. fl.-, & fr.-sp. (Biol. Lab. Teikyo Univ.).

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## 田中教之: ***Helonias*** 属と ***Ypsilandra*** 属（ユリ科）の花部形質とその分類学的示唆

*Helonias* 属は北米東部に分布する単型属であり，*Ypsilandra* 属はヒマラヤから中国東南部にかけて分布する小属で，両属共にユリ科に分類される (Krause 1930, Hutchinson 1934). 両属は地理的には新旧両大陸に隔離分布しているが，互いに近縁な属である．両属はこれまで主として花柱や葯の形態によって区別されてきた．今回，生品と標本に基づいて両属を比較観察したのでその結果について報告する．

(1)これまでの多くの記載によると，*Helonias* は3花柱を持つとされてきたが，しばしばそれらの花柱の基部はごく短いが合成した一つの柱状部を持つことが確認された．このことは，3花柱が合生し，常に柱状の花柱部分を持つ *Ypsilandra* と質的に異なるものではないことを示している．(2) *Helonias* の葯は2個の半葯からなり，半葯間での連合はないとこれまで記載されてきたが，筆者の観察では，葯の頂部は半葯間で連合し，実質的に一室化していることが確認された．葯の頂部が半葯間で完全に連合一室化するという性質は *Ypsilandra* の観察したすべての種（*Y. yunnanensis*, *Y. alpina*, *Y. cavaleriei*, *Y. thibetica*）においても存在するので，両属はこの点でも共通する性質を持つことが判明した．(3) *Helonias* の内花糸は子房の基部と組織的に合生しているが，外花糸は子房とは離生している．これらの性質は *Ypsilandra* の4種でも花時に存在することが今回確認された．(4) *Helonias* の花には蜜腺がないとこれまで記載されてきたが，筆者は花被片の内面基部において，蜜が実際に分泌されているのを確認した．また，*Y. thibetica* でも花被片の同じ部分から蜜が分泌されているのを確認した．花被片下部の形態から判断すると *Ypsilandra* の他の3種でもこの性質は存在するものと思われる．(1)～(4)の性質に関して本研究で確認された事実は，両属の種がこれまで考えられていたほどには隔たっているものではなく，両属の種をこれまでのように属ランクで分類することに少なからず疑問を投げかけるものである．

ここで扱った両属と日本などに分布するショウジョウバカマ属（*Heloniopsis*）とは互いに密接な関係にある．この属も含めて，今後はさらに多くの性質について比較研究する必要がある．

(帝京大学文学部教育学科)